Northwest Power and Conservation Council

March 7, 2006

MEMORANDUM

TO: Council Members

FROM: Steve Waste, Manager for Program Analysis and Evaluation

SUBJECT: *Draft* Guidance for Developing Monitoring and Evaluation in the Program

Action

This guidance document proposes an approach for developing a programmatic scale monitoring component for the Fish and Wildlife Program.

Recommendation

Staff recommends releasing the monitoring guidance document for review by the region.

Background

This document proposes guidance on monitoring for two different audiences. The first and second chapters provide the Northwest Power and Conservation Council and other policy makers the rationale and context for this guidance. Chapter one explains the importance of developing a regional approach to monitoring. Chapter two describes the primary elements of a regional approach to monitoring, including high-level indicators, provincial scale objectives, and project scale work, and how they are linked.

Chapters three and four are intended for the practitioners of monitoring. Chapter three describes the current monitoring components of the Program, some of which are well developed. It also provides guidance on how the project selection process can be used to develop programmatic scale monitoring for the Fish and Wildlife Program. Chapter four describes the categories of monitoring under which work will be initiated to implement a programmatic approach.

Discussion

This guidance is presented for Council discussion. The staff asks for Council approval to release this draft for regional comment. Following comment and revision we propose seeking ISAB review.

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Draft Guidance for Developing Monitoring and Evaluation as a Program Element of the Fish and Wildlife Program

Northwest Power and Conservation Council
March 2006

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I. Developing Monitoring and Evaluation in the Program

This document provides guidance on monitoring for two different audiences. The first and second chapters provide the Northwest Power and Conservation Council (Council) and other policy makers the rationale and context for this guidance. Chapter one explains the importance of developing a regional approach to monitoring. Chapter two describes the primary elements of a regional approach to monitoring, including high-level indicators, provincial scale objectives, and project scale work, and how they are linked.

Chapters three and four are intended for practitioners of monitoring. Chapter three provides guidance on how the Council will use the project selection process to help develop programmatic scale monitoring in the region. Chapter four describes the categories of monitoring under which work will be initiated to implement a programmatic approach and includes specific guidance on tasks.

Why Monitoring is Important: Evaluating the Fish and Wildlife Program

The 2000 Fish and Wildlife Program (Program) establishes a basinwide vision for fish and wildlife along with four overarching biological objectives:

- A Columbia River ecosystem that sustains an abundant, productive, and diverse community of fish and wildlife
- Mitigation across the basin for the adverse effects to fish and wildlife caused by the development and operation of the hydrosystem
- Sufficient populations of fish and wildlife providing abundant opportunities for tribal trust and treaty right harvest and for non-tribal harvest
- Recovery of the fish and wildlife affected by the development and operation of the hydrosystem that are listed under the Endangered Species Act

The principal vehicle for implementing these objectives are the restoration projects to improve conditions for listed and non-listed anadromous fish, resident fish, and wildlife that have been impacted by the hydrosystem in the Columbia River Basin. The central question for the Council is whether or not the projects are in fact helping the Program reach these objectives. This guidance will facilitate the development of a monitoring component for the Program that over time will provide the basis for a quantitative assessment of progress toward the Program's overarching objectives. Specific provincial scale objectives that will be developed in 2006

Why Monitor at a Programmatic Scale?

In the Pacific Northwest, natural resource management entities collect and analyze many types of information for answering specific management questions to address the objectives for which they are responsible**.** To effectively combine information to answer

management questions will require monitoring across multiple geographic and temporal scales, including:

- Tributaries with major projects, populations
- Major population groups
- Subbasins
- Evolutionarily Significant Units
- Major Population GROUPS
- the Columbia River Basin

Developing standardized approaches, making and securing long-term funding commitments, and coordinating with our regional partners are all essential to the success of this initiative.

The Pacific Northwest Aquatic Monitoring Partnership or PNAMP, is working to develop standardized protocols and methods for field data collection, data management, and analytical processes, which, in widespread use, would change this data into a common currency. This would enable data collected for an initial primary purpose to maintain value for use by subsequent secondary users wishing to analyze aggregate data, or "rolling-up" the data, following a set of universal guidelines. Similarly, there is value in being able to combine information even within the same watershed or nearby watershed to increase the inferences or statistical power of information.

While there are many potential analytical applications for aggregate data, this guidance identifies the need to coordinate the collection of data in a manner that can support evaluation and decision-making at higher-level spatial scales, for example subbasin plans, Evolutionary Significant Units, and provincial scale objectives. By supporting this work it will be possible to conduct basic assessment and evaluation work at the population level, and at a regional scale.

This increases the potential for technical, policy and public organizations to communicate using consistent language and processes and to provide accurate and unambiguous information to the public, NGO's, governments and their branches. Enabling operational adaptive management and well-informed decision-making will be the principal results of this initiative.

Where the Program Stands Today

Until now, monitoring in the Fish and Wildlife Program has primarily been conducted to evaluate work at the project scale, across all subject areas. This approach has generated monitoring information useful to individual restoration projects. However, monitoring

has not been developed into an element of the program that can provide a basis for evaluating the program. Consequently, the Program must now apply limited resources to developing a more programmatic approach, which can detect the cumulative effect of restoration actions. By developing the ability to conduct such evaluations, the program will be able to identify future actions that are more strategic. Identification of high-level indicators and the development of provincial scale objectives will be required to support this programmatic approach.

While monitoring of work at the project scale has intrinsic value, and will continue on a reduced basis, it cannot substitute for the lack of a monitoring program of sufficient scope to provide a basis upon which the program as a whole can be evaluated, and re-directed. Monitoring must be conducted at different scales to:

- Assess the performance of the program relative to biological and programmatic objectives
- Identify where and why there are performance problems
- Identify the most effective actions needed to correct problems so that program objectives can be achieved

Developing a Regional Approach to Monitoring: Spatial Scales

The absence of a regionally coordinated approach to monitoring and evaluation in the Columbia River Basin has constrained restoration and planning efforts for decades. For this reason, it is important that a more hierarchical approach be utilized with increased emphasis on achieving useful outcomes from monitoring. Specifically, methods need to be developed and implemented so that monitoring results can be combined at the same scale, or rolled up to higher scales to provide scientifically defensible evaluations . For example, to determine whether the status of fish and wildlife populations and/or ecological condition of a subbasin, an ESU, or the Columbia River Basin as a whole is improving or declining over time. This capability would be very useful to policy and decision makers as they deliberate on future actions under the program that affect the long-term, ecological health of the basin.

Shifting the focus of monitoring from project to larger spatial scales has both benefits and challenges. One benefit of focusing on the population scale is that it's a scale with direct relevance to fish managers, who want to know if actions within a watershed can actually improved a fish population's production, for example smolts/spawner, in addition to improving habitat conditions in the restored reaches. The population scale is also of great interest to agencies like NOAA Fisheries charged with evaluating the status of listed populations.

There are also some significant challenges in shifting monitoring to larger spatial scales. Reliably attributing observed changes in fish survival or production to particular sets of management actions requires careful monitoring design. Otherwise, one might

erroneously infer that observed changes were due to management actions when in fact they were the result of natural variation in freshwater climate or ocean conditions. Ideally, one would monitor both 'treated' areas (those with habitat restoration actions) and nearby 'reference' areas (those without restoration actions), for several generations of fish populations, both before and after implementation of actions, and measure other explanatory variables simultaneously. One challenge is that it becomes increasingly difficult at larger scales to establish the strong contrasts required to evaluate effectiveness; that is areas and times with and without certain classes of restoration actions. For example, adjacent subbasins will each have a variety of implemented restoration actions, so that comparing fish production across these subbasins and over time will not lead to any clear inferences on which actions (if any) were responsible for any observed differences in trends over time. It will therefore still be necessary to conduct effectiveness evaluations at finer spatial scales for a carefully selected subset of restoration actions and locations.

Determining Biological Effectiveness: The Role of Adaptive Management

Adaptive management provides a valuable tool for ensuring that timely feedback from program activities increases effectiveness by re-directing future work. In their seminal work applying adaptive management in a hydropower context, Professor Kai Lee and Jody Lawrence wrote:

> Adaptive management encourages deliberate design of measures. This assures that both success and failures are detected early and interpreted properly as guidance for future action. Information from these evaluations should enable planners to estimate the effectiveness of protection and enhancement measures on a systemwide basis. Measures should be formulated as hypotheses. Measures should make an observable difference. Monitoring must be designed at the outset. Biological confirmation is the fundamental measure of effectiveness. (Emphasis added.)

(From *Adaptive Management: Learning from the Columbia River Basin Fish and Wildlife Program*, Environmental Law Vol.16:431-460, 1986.)

The National Research Council (NRC) reported several lessons learned about the practicability of adaptive management and the institutional conditions that affect how experiments on the scale of an ecosystem can be conducted (NRC, 1996), specifically:

- Learning takes from decades to as long as a century. Patience is both necessary and difficult, particularly in institutional settings such as government that work in faster cycles

- Systematic record keeping and monitoring are essential if learning is to be possible

- Cooperative management in the design and execution of experiments is indispensable

- Experimentation within the context of resource use depends on the collaboration of resource users

- Adaptive management does not eliminate political conflict but can affect its character in important, if indirect, ways

Monitoring and evaluation is at the heart of the adaptive management because it provides the information, data and analysis for identification of need and subsequent tracking the progress of plans and population, or their lack of progress, for decision-makers and resource managers. The success of the program depends on the consistent application of well-designed research, monitoring and evaluation that can enumerate the information required for different types of decisions at multiple scales, for example management of harvests, the hydrosystem, and hatcheries; and, decisions on the protection and restoration of habitat.

Another key element to an adaptive management experiment is providing a large enough perturbation to a system so a detectable change in a response variable can be measured. For example, by measuring responses to a limited range of spill and flow levels in the Columbia River hydrosystem, it will be difficult to assess detectable changes over the salmon and steelhead life-cycle and to contrast those changes in life-cycle survivals to those for transported juvenile fish.

To be successful, adaptive management requires that "triggers" be established for initiating adjustments or changes based on the results of monitoring. Monitoring without triggers and adjustments does not constitute, and cannot support, adaptive management. Triggers should be identified, required, and be more than checkpoints in time. For example they could be related to performance standards, or achievement of deliberate experimental design outcomes, or management targets. Thus, failure to attain performance standards as expected, on the stated timeframe, should trigger the appropriate review of what happened, why, and the determination of next steps. The following steps to implementing adaptive management are portrayed in Figure 1:

- Assessing limiting factors and critical uncertainties

- Designing projects, programs and monitoring to maximize both on-the-ground effectiveness and learning

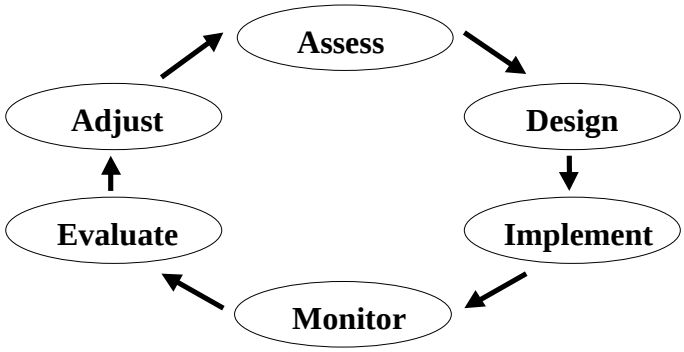
- Coordinated and documented implementation of projects

- Consistent monitoring through standardized methods, protocols, and training

- Timely and thorough evaluation of effectiveness

- Overall guidance to the region to adjust plans and programs at the Province and subbasin level

Figure 1. Sequence of steps in adaptive management.



A Regional Scale Program Requires Regional Scale Monitoring

For over a decade the Program's science review groups have been calling for the "development and implementation of a system-wide monitoring and evaluation program," (SRG 93-2). The objectives and management questions of the Program overlap those of many other regional entities and, local state, federal and tribal governments. The costs of the monitoring and research needed to adequately address these common management questions are more than one program can adequately support or fund alone. Only through the combined efforts of multiple entities can a sufficient level of information be developed to answer resource management questions through coordinated, standardized and programmatic approaches to monitoring. There are a number of existing efforts in the region to coordinate monitoring and evaluation but until recently there has been a lack of an organizing principle or central forum to facilitate these efforts.

Pacific Northwest Aquatic Monitoring Partnership

The 2000 Fish and Wildlife Program, Basinwide Provision D.9, states that:

> "The Council will initiate a process involving all interested parties in the region to establish guidelines appropriate for the collection and reporting of data in the Columbia River Basin."

Another directive for developing a regional approach to monitoring was included in the "Recommendations of the Governors of Idaho, Montana, Oregon and Washington for Protecting and Restoring Columbia River Fish and Wildlife and Preserving the Benefits of the Columbia River Power System," issued in June of 2003. In response, Council staff has joined and helped inaugurate the Pacific Northwest Aquatic Monitoring Partnership, or PNAMP, chartered to provide such a forum (*see* www.pnamp.org). Through their participation in PNAMP, the Council, Bonneville, and the fish and wildlife managers are

working to implement the Program within the context of a regional network of monitoring efforts so that the shared monitoring needs and objectives of the program can be achieved. Major accomplishments of PNAMP relevant to the development of a regional approach to monitoring include the following several key operational documents:

- Draft Plan 2004, titled, "Recommendations for Coordinating State, Federal, and Tribal Watershed and Salmon Monitoring Programs in the Pacific Northwest," on January 6, 2004.
- Considerations for Monitoring in Subbasin Plans 2004
- Strategy 2005
- Charter 2005

In addition to providing staff support for this regional initiative, the Council has also funded the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP), designed to facilitate implementation of monitoring within the Columbia Basin. CSMEP is a three-year project funded under the Program that is working on several of the tasks identified as priorities by the Fish Monitoring Workgroup of PNAMP, NOAA, USFWS, and the Action Agencies. In close coordination with PNAMP, the CSMEP has been working since October 2003 to develop rigorous approaches to monitoring and evaluation that directly serve the needs of specific decisions, and build on the strengths of existing monitoring infrastructure. PNAMP and CSMEP have been, and will continue to, work closely together.

PNAMP is playing a key role in the development of coordinated approach to monitoring at a regional scale. It provides a central forum for the discussion of policy and management issues and sponsors workgroups comprised of monitoring practitioners working to resolve technical issues. PNAMP is the key forum for implementing the regional framework for monitoring described in Chapter II.

Collaborative Funding

In 2000, the Council shifted from an annual project funding cycle to a three-year cycle. Because state and federal agencies remain on an annual funding cycle, it is difficult for them to make long-term funding agreements. Consequently, formal arrangements such as memoranda of agreement (MOAs) may be necessary to secure long-term funding commitments for selected large-scale field experiments, for example the MOA between Bonneville and the U.S. Forest Service. In regard to the Program, it is important to acknowledge the difficulty inherent in reprogramming existing funds to support additional research initiatives within the available direct-program budget.

Yet the important question is not how much investment in additional monitoring the program might afford, but rather how to implement a comprehensive regional research agenda that can be funded from multiple sources, sustained, and managed to mutually endorsed outcomes. A more systematic and strategic approach to leveraging investment by many parties is warranted. This guidance identifies critical uncertainties that need to

be addressed by multi-agency initiatives, cooperative funding agreements, and the sharing of responsibility for implementation.

Some identified monitoring needs are currently, or should be more appropriately, the requirement or shared responsibility of federal or state agencies other than Bonneville, under mandates other than the Northwest Power Act. This point is particularly relevant to ESA recovery planning and implementation research needs that are proposed for the Columbia River Basin but have application coast-wide. Discrete elements of this guidance present differing degrees of opportunities for regional coordination and shared funding. To succeed, it is incumbent upon members of PNAMP to develop and implement incentive strategies. Incentives may include funding, regulatory flexibility, or recognition, all of which can work in combination. Thus, there is a need to work cooperatively with entities that represent alternative funding sources and have responsibilities that overlap those of the Council, for example the Trust for Public Lands and others. The regional entities should recognize that all programs are limited by what they can afford to sustain, but that by working together, all the programs could benefit from focused, coordinated expenditures.

Inventory

It would be valuable for long-term planning of monitoring and evaluation to assemble a comprehensive and detailed inventory of all monitoring activity in the Pacific Northwest region. The inventory should be structured to provide a web-based, searchable database. The benefit here is clear: knowing who is doing what, where, why and how, will enable cost savings through elimination of duplicate work, and enable a higher level of collaboration and communication. This inventory will also identify critical gaps and areas where strong and weak data sets currently exist.

CSMEP has conducted detailed inventories, and assessments of the strengths and weaknesses, of data within a dozen subbasins of the Columbia Basin. These very detailed data inventories, which are available on an internet-accessible website, need to be complemented by a broader, less detailed inventory to be developed by PNAMP. Additional inventory work, on the scale of the entire Pacific region, is being conducted by the State of Salmon project, a joint effort of Ecotrust and the Wild Salmon Center.

Data Management

A regional approach to monitoring will fail without the support of a data management system that can provide regional access to the data sets developed through monitoring efforts, on a timely basis, for analytical manipulation. To be successful a data networking system must be able to assist scientists in the identification and development of data standards as it relates to the monitoring of fish and wildlife populations and their related habitats. This objective helps to identify solutions that improve access, sharing, and coordination among different collectors and users of monitoring data for fish and wildlife populations and their related habitats. It also provides a data reporting

foundation that will lead towards coordinated agency reporting, uniform monitoring protocols, and improved data quality and quantity. Objectives include:

- Develop a consistent data standards and protocols within and across each of the types of monitoring
- Establish a close working relationship for data consistency across the data sources
- Identify and document the specific data needs of the region for watershed condition monitoring, fish population monitoring, and effectiveness monitoring
- Develop and recommend data collection standards and information to be shared across the various monitoring programs
- Share requirements and results with regional data networking entities to ensure sharing of monitoring data
- Test the collection protocols, sampling methods and data sharing mechanisms
- Implement coordinated solutions within regional programs
- Embed common analysis capabilities and reporting capacity
- Provide public access sections or linked web sites for informational and collaborative processes

There are many different interests and initiatives concerned with improving data collection or management in the Columbia Basin and the Pacific Northwest. These efforts involve many different constituencies, mandates, and obligations. At present, there is no common regional data management network that links these interests and initiatives. To address this situation, the Council has initiated a process for identifying data needs in the basin, surveying available data, and filling any data gaps. The Council, NOAA Fisheries, and other regional entities supporting this effort consider it imperative to develop a regional data network that will:

- Utilize existing databases, facilitate data management and sharing
- Help subbasin planners
- Underpin salmonid recovery efforts under the FCRPS Biological Opinion
- Support the monitoring component of the Council's Program

The Northwest Environmental Data Network or NED is leading this initiative. PNAMP scientists, statisticians and biologists plan to develop data collection standards that can be used across many different programs. NED could then support the consistent use of these

standards and in addition develop data sharing standards as a part of an overall regional data network. NED will also work with other regional groups to support consistent standards for their data collection programs. In this way NED will support the sharing and integration of many different regional data sets including the PNAMP data.

There are important differences in the expertise needed for PNAMP and NED, while PNAMP is primarily made up of scientists, statisticians and biologists, NED will be supported by information network specialists whose role is to work with regional scientists and others to make the information that they collect more consistent and more readily available. This "corporate" approach to organization realizes the efficiencies and benefits that can be gained from introducing standards to information systems while supporting the flexibility that is needed by the many different data collection sub-disciplines. It is also consistent with the recommendations that the region has received on data management and science by the Council's Independent Science Advisory Board and the Independent Science Review Panel.

The methods and protocols used in the collection of data for use within the Fish and Wildlife Program must be consistent with guidelines approved by the Council and adopted by the region. It is important to note that while the ISRP checks these criteria, it is Bonneville who must enforce the guidelines. Guidelines appropriate for the collection and reporting of data at the project scale include:

- The project must have measurable, quantitative biological objectives
- The project must either collect or identify data that are appropriate for measuring the biological outcomes identified in the objectives
- Projects that collect data appropriate for secondary use, for example subsequent higher scale evaluations, must make this data and accompanying metadata available to the region in electronic form
- Data and reports developed with Bonneville funds should be considered to be in the public domain
- Data and metadata must be submitted within six months of their collection

II. A Road Map for Developing a Regional Monitoring Framework

Management Questions and the Need for Supporting Data

Many of the objectives and management questions of the program overlap with those of other regional entities and local, state, federal, and tribal governments. Consequently, existing regional monitoring programs are being networked based on a monitoring framework developed by PNAMP comprised of:

- Common management questions and information needs supporting the management questions

- Common research, monitoring, and evaluation categories, monitoring designs and protocols that allow the communication and networking of regional programs

- Common understanding on responsibilities and cost sharing of the monitoring needs

The regional framework for monitoring depicted in Appendix A. identifies the types of monitoring activity ongoing, or needed, in support of the management questions. These management questions have several subordinate questions and supporting information needs that fit within the regional monitoring framework. This framework provides an organizing structure for identifying the types of monitoring activity needed in support of management questions and the roles and responsibilities of the parties who share the management questions. Source documents that have contributed to the conceptual foundation of the regional framework include:

- Monitoring Section of ISRP's Retrospective Report – NPCC 2005

- Research Plan for the Columbia River Basin – NPCC 2006

- Strategy for Coordinating Monitoring of Aquatic Environments in the Pacific Northwest – PNAMP 2005

- Considerations for Monitoring in Subbasin Plans 2004 – PNAMP 2004

- Conservation of Columbia Basin Fish; Final Basinwide Salmon Recovery Strategy - Federal Caucus 2000

- Research, Monitoring, and Evaluation (RME) Plan for the NOAA Fisheries 2000 Federal Columbia River Power System (FCRPS) Biological Opinion - Action Agencies and NOAA 2003

- ISAB and ISRP Review of the Action Agencies and NOAA Fisheries' Draft Research, Monitoring & Evaluation Plan for the NOAA-Fisheries 2000 Federal Columbia River Power System Biological Opinion (RME Plan) - ISAB and ISRP, 2004-1

- Updated Proposed Action for the FCRPS Biological Opinion Remand - Action Agencies 2004

- Proposed Design and Evaluation of Preliminary Design Templates – CSMEP 2004

- Data Quality Objectives for Decisions Relating to Status and Trend of Fish Populations, as well as Action Effectiveness of Habitat, Hatchery, Harvest and Hydrosystem Actions - CSMEP

- Scope of Work for Implementation of the Northwest Environmental Data Network Project - Northwest Environmental Data Network 2005.

The management questions and project categories of this regional framework have been developed through ongoing regional coordination efforts. PNAMP is currently conducting a survey of the management questions important to its members. The results of the survey will be presented and discussed at the 2nd Annual PNAMP/CSMEP Workshop, to be held March 16-17, 2006. PNAMP will then initiate a policy level discussion of the results of the survey and the workshop.

The development of standard monitoring protocols and the identification of regional responsibilities and cost-sharing agreements is underway. To answer each of the monitoring questions established in the regional framework (Appendix A.) will require specific data, protocols, and objectives. The project selection process can be used to support work that can help determine how data can be combined and reported throughout the basin.

The remainder of this section outlines the three main layers of activity necessary for the Program to develop a programmatic approach while concurrently implementing the regional framework.

- High Level Indicators - Basinwide
- Provincial Scale Objectives - Subregional work, for example, hatcheries
- Projects Scale Results - Bottom up, for example, specific results, and associated data stream

High Level Indicators: Monitoring for the Program

Resource management agencies need high-level indicators that flow explicitly from on-the-ground monitoring programs to provide information on whether progress towards meeting biological objectives has been made. Communicating the results of such

evaluations, and the rationale they may provide for changing the direction of management activities, requires high-level indicators that can be easily understood by all interested parties in terms of every day definitions and experiences.

Through the coordinated use of high-level indicators, a uniform message about the health of watersheds and aquatic resources can be communicated to the public with a common language, using the same terms, and conducting analyses that allow comparison of findings, and ultimately, to similar conclusions. Scientific jargon, acronyms, and complex metrics fail to convey important information to the decision makers who provide the funding that enable monitoring programs to function at a cost-effective and reliable level (*see* Appendix B. Definitions of Monitoring Terms).

The data pyramid in Figure 2. illustrates the relationships between the types of information and how they can support decision-making. For example, the status of high-level indicators compels the activities at the bottom of the pyramid, for example on the ground methods, protocols, and logistical implementation requirements. They also can help direct decisions and recommendations about the analytical processes and statistical designs in the middle of the pyramid.

For example, the status of high-level indicators compels the activities at the bottom of the pyramid (for example, on-the-ground methods, protocols, and logistical implementation requirements). They also can help direct decisions and recommendations about the analytical processes and statistical designs in the middle of the pyramid.

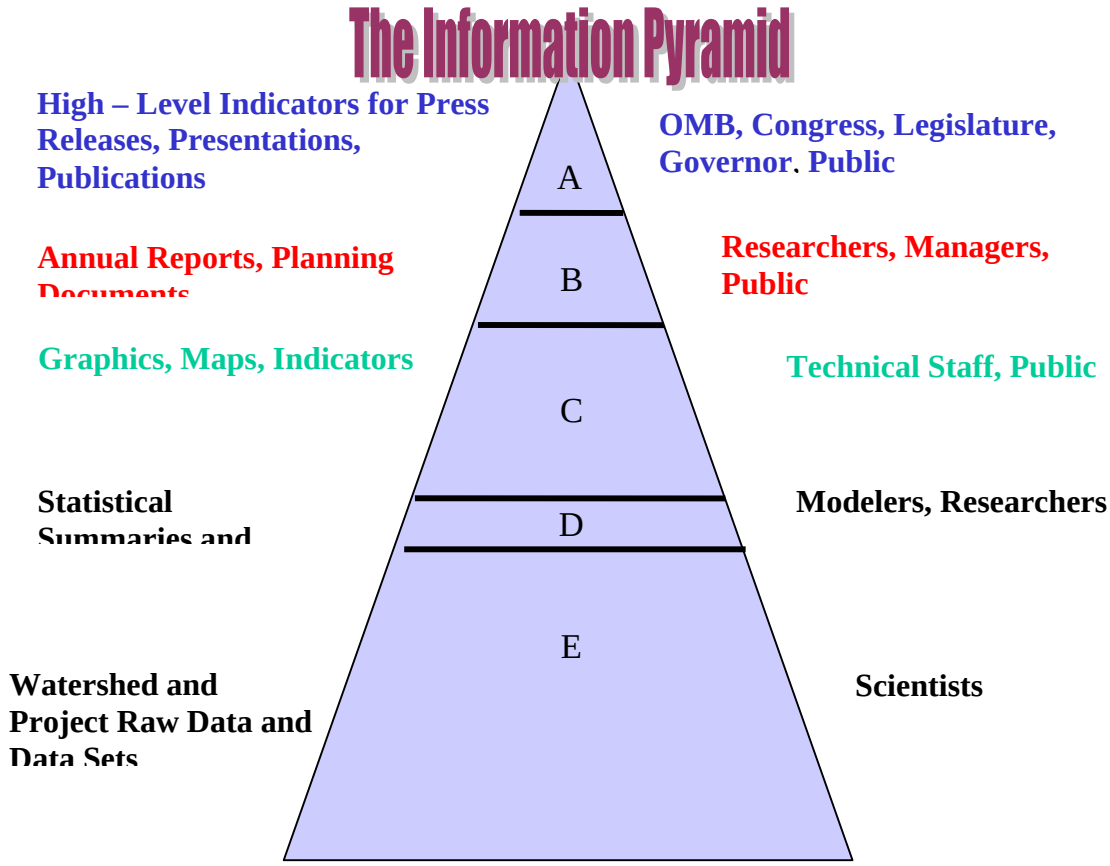
What are High-Level Indicators?

For the purpose of this guidance, high-level indicators are defined as:

> *Variables that are monitored for the purpose of physical, biological and sociological change analysis and evaluated at a programmatic and population scale. These may be broad-spectrum environmental variables, for example water quality or sediment load, because of varied ecotypes and landscapes. They may also be discrete factors such as numbers of fish or sociological indicators. Thus, the use of the term "high" is intend to describe activity that occurs at or across a broad scale and is not intended to describe a high degree of detail.*

High-level indicators are comprised of, and provide an aggregate value for, data collected at lower scales and are intended to report cumulative results and summary findings, conclusions, and ultimately, management recommendations. Many types of data are of interest to the Council and the other members of PNAMP and are collected to meet a primary mandate of the collecting entity, especially when varied ecotypes and species' life-history differences are concerned.

Figure 2. In the monitoring information pyramid, examples of types of information are on the left and related users or generators of that information are represented on the right.



Why Are High Level Indicators Important?

The challenge and the promise of high-level indicators is that they bring focus to the organization of the data collection efforts on the ground, by requiring uniformity and consistency in data collection, management, analysis, protocols and methods. When such consistency has been achieved, then like data, from different areas and sources can be aggregated into a specific number with confidence, for a broader geographic area. Similarly, related but unlike data can be aggregated into a composite value, for example indices for water quality. To achieve a regional approach to monitoring that is scientifically credible will require the coordination of lower and mid-level data collection efforts to ensure the consistency necessary to support secondary, yet higher scale use of the data. Thus, lower scale data is important both for its intended original application and because it constitutes the building blocks upon which higher scale evaluations can be constructed.

How High Level Indicators Are Being Identified

A subcommittee of PNAMP is developing a pool of high-level indicators for endorsement by its Charter member agencies for use within the Pacific Northwest region. PNAMP members will be able to draw from the pool of indicators appropriate for their own reporting needs, while concurrently building data sets useful for subsequent evaluation. For example, high-level indicators will be used as the basis for developing provincial scale objectives in the Fish and Wildlife Program. The PNAMP document "Strategy for Coordinating Monitoring of Aquatic Environments in The Pacific Northwest," and derivative work plans have previously recognized the need for high-level indicators.

The Councils' Fiscal year 2007-2009 project selection process provides an opportunity to fund work on the implementation of high-level indicators in the context of the Program. Therefore, pending completion of the work of PNAMP subcommittee, Council staff is recommending the use of this provisional set of high-level indicators. This set follows the example of the State of Washington, as well as projects supported by the National Science Foundation bio-complexity program, for example, by including physical, biological, economic, and social science indicators, as appropriate.

Provincial Scale Objectives: When and Where to Monitor for the Program

The broad biological objectives of the Council's Fish and Wildlife Program were introduced at the beginning of this plan. More detailed and quantifiable program objectives will be developed as part of the Council's initiative to develop provincial scale objectives. The process of developing, negotiating, and gaining regional acceptance of provincial level objectives will occur in the context of an Program amendment process that will be initiated in 2006. It will be important for these provincial-scale objectives to encompass a set of core objectives common to the four states, while respecting additional reporting needs of the individual states. Once established, provincial-scale objectives will provide specific targets by which the effectiveness of the program can be evaluated.

Each province will have a unique mix of target numbers for the high-level indicators being monitored based on their subbasin plan objectives, Program objectives, and ESA objectives. The Fiscal Year 2007-2009 project selection process provides a vehicle for the Council to support projects that can develop the structures of, and give form to, a coordinated network of regional monitoring programs to support evaluation of the provincial scale objectives.

Fish and Wildlife Program Projects: the Building Blocks of Regional Monitoring

The following management questions identify the monitoring priorities that should be implemented in the Fish and Wildlife Program.

1. Are we meeting biological and programmatic performance objectives established within the Columbia Basin Fish and Wildlife Program; for example, subbasin plans and

mainstem amendments; FCRPS BiOp; and ESA Recovery Plans? If not, how should we change current management?

- Status and Trend Monitoring of adult fish abundance, adult and juvenile survival through the hydrosystem and changes in survival or productivity, distribution and diversity associated with offsite mitigation actions, as appropriate.

- Implementation and Compliance Monitoring to assess project outcomes relative to project objectives and programmatic level standards for example, provincial scale objectives.

2. What factors are limiting our ability to achieve performance standards or objectives?

- Fish Population and Habitat Status and Trend Monitoring for limiting factors at each life stage.

- Uncertainty Research to better understand the underlying relationships between fish population performance and habitat conditions.

3. What mitigation actions are most effective at addressing the limiting factors?

- Action Effectiveness Research targeting specific limiting factors and associated mitigation actions.

The management questions will be answered based on information collected through the regional monitoring activities defined in Appendix A. In Table 1. the monitoring components of the Program are set forth with management questions and implementation steps for 2007-2009 project selection process. The broad range of work set forth in the table will likely require two funding cycles to be fully implemented. A strong start can be accomplished in the 2007-2009 cycle.

An example of these types of monitoring activities might be conducted in a watershed is illustrated in Figure 3.

Figure 3. Types of monitoring data collected in the Columbia River Basin associated with geographic locations.

* Graphic under construction, insert following Table 1. when completed.

Table 1. Monitoring and evaluation measures in the Fish and Wildlife Program.

Monitoring Component	What do we want to know?	What needs to happen in 07-09 project selection process
Hydro System Survival	Is juvenile and adult survival through the dams meeting passage objectives	1.Review current smolt monitoring program. 2.Review adult PIT tag detection needs. 3.Coordinate with Corps-funded components.
Hydro Uncertainty Research	What are the delayed effects of transportation and migration through the hydro system?	1. Review design and past results of Comparative Survival Studies (CSS) 2. Review scope and function of PIT tagging
Tributary Habitat Trends	Are ecosystems improving or degrading relative to the conditions subbasin plans called for?	Much of this work is funded from outside of the Program. 1. **Propose specific indicators to prioritize for data collection**. 2. Prioritize funding for regional collection 3. Confirm standard collection protocols through PNAMP/CSMEP. 4. Inventory current work performed with BPA funding and plan any needed transition to standard protocols.
Tributary Habitat Action Effectiveness	What types of projects are effective at addressing limiting factors?	1. Two of three planned Intensively Monitored Watersheds are being implemented with BPA funds. 2. Third being designed. 3. Proposal review in Mainstem/Systemwide. 4. Limit other habitat project-specific monitoring to "soft cap" of 5 percent.
Population status and trends	Are populations meeting objectives for abundance, productivity and diversity?	1. Review currently funded methods and locations in proposals. 2. Review CSMEP's work plan proposal.

		3. Prioritize regional-scale collection and protocols
Hatchery Effectiveness	Does supplementation help rebuild populations?	1. BPA funded projects have established monitoring designs 2. Review CSMEP proposal for tasks to link individual projects into a regional experiment (see ISAB/ISRP 2005-15) 3. Establish expectations in 07-09 decision document.
Hatchery status and trend monitoring	What are hatchery numbers of salmon and steelhead relative to naturally spawning populations?	1. ISRP review of monitoring methods at BPA-funded projects. 2. Review data delivery for regional evaluation
Estuary habitat status and trend	Is the Columbia estuary ecosystem improving or deteriorating relative to desired conditions	1. Confirm objectives and funding share for currently proposed estuary pilot project.
Harvest trends	What is the harvest impact on Columbia populations?	1. Confirm function dam counts towards this question in Mainstem/Systemwide review
Data Management	Establish an Internet-based system to disseminate the data needed to respond to these management questions	1. Implement NED work plan. 2. Review functions of StreamNet and consistency of project reporting with Program standard (p. 33).
Basinwide and province evaluation	Are the individual actions in the various subbasins achieving the objectives at the basin and province levels	**1. Propose the "high level indicators" for broader evaluation**. 2. Provincial objectives amendment process should define benchmarks
Reporting	Present status of populations relative to work funded by Program	1. CBFWA is proposing to assemble such a report on behalf of the Program. **Confirm content.**

III. Using the Project Selection Process to Implement Monitoring

What Does it All Mean? Paradigm Shift Ahead

The project selection process for Fiscal Years 2007-2009 provides an opportunity to implement many of the concepts and principles that the Council has helped to develop through its participation in PNAMP. This guidance explains how the implementation of a regional approach to monitoring can be advanced through the project selection process.

The Columbia Basin has already developed some of the components of an effective and economical long term monitoring program, for example, counts of returning anadromous adults at dams, estimates of number of out-migrating juveniles, harvest estimates, hatchery production, etc. Yet these components need to be linked, and additional components developed, including long term PIT tagging of important populations of anadromous fish, coordinated estimation of spawners or escapement into tributaries by standardized sampling and estimation methods, and standardized habitat and water quality sampling and estimation methods.

Taken together, the different aspects of the paradigm shift in monitoring will constitute a significant change and an important improvement to the Program. It will take more than one funding cycle to institute these changes. It will take more than two funding cycles to generate the data necessary to answer some of the management question posed in this guidance, and the critical uncertainties identified in the Council's Research Plan.

Developing a Monitoring Component of the Fish and Wildlife Program

The nature of the shift ahead is away from the past practice of single year, project specific data collection. This data had one time use, as it was not collected for the purpose, or stored in a manner, that made it accessible for future analytical manipulation. Future data collection at the project scale that should:

- Follow PNAMP endorsed protocols as they become available to foster uniformity in data collection, and to improve consistency in the data

- Be compatible with the data requirements of the Pacific Coastal Salmon Restoration Fund (*see* also section on data management)

- Comply with the reporting metrics of Bonneville's Pisces

Permanent networks of monitoring sites have been demonstrated to be the most cost-effective way to monitor at large scales (Oakley et al. 2003). Therefore, the Program should develop a long-term network of monitoring sites through the initiation of research, planning, and field-work in the 2007-2009 funding cycle. Development of such a network will be achieved in a phased approach that incorporates existing monitoring programs to the extent possible. The proposed network will support triennial reporting of the results of Program evaluation.

The long-term monitoring network will be complemented by near-term H-specific monitoring at subregional scale to address questions identified in the Research Plan for the Columbia River Basin. For example, a workshop will be held April 6-7, 2006, to coordinate monitoring to within existing projects to address the recommendations in the ISAB's Review of Salmon and Steelhead Supplementation (2003-3).

Making a Long-Term Commitment to Monitoring

To make adaptive management a reality will require a long-term commitment to science-based evaluations of management actions. Evaluating the occurrence and magnitude of trends requires a commitment to monitoring for multiple years, and consistent data collection through a network of sites relevant to the objectives of interest. Although substantial research has been conducted on trend detection for example, form of trend, best tools to detect trend (Esterby 1993), there has been little discussion in the ecological literature of what constitutes a ''policy-relevant'' trend and how well we can measure or detect it (Urquhart, Paulsen and Larsen, 1998).

Conducting Large-Scale Field Experiments

Large-scale field experiments to support the development of a monitoring network should be conducted collaboratively through shared funding arrangements with other entities. It might be argued that there are already de-facto large-scale field experiments underway, but they were not designed to resolve specific uncertainties or establish cause and effect relationships. It may also be possible to link project-scale efforts together in order to achieve large-scale field experiments, such as by sharing controls for hatchery and habitat projects. However, the current funding structure does not facilitate development of controls; for example, much of the research on hatchery effectiveness has been done without paired study of natural production. Similarly, much of the research on habitat treatments has been conducted without paired control sites. For these reasons, current monitoring activity that resembles large-scale field experiments does so by default, not by design.

Point of Departure: Getting Underway for Fiscal-Year 2007-2009

A workgroup comprised of Council, Bonneville, and CBFWA staff and will be convened within the Mainstem/Systemwide project review to help identify projects that will be most likely to be effective at achieving program objectives and implementing the regional monitoring framework. The following draft steps are recommended for the effective allocation of limited Program resources:

- Identify the suite of management questions that need answers to effectively meet the objectives of the Fish and Wildlife Program *(PNAMP Survey and Workshop)*
- Identify RM&E needed to address these management questions *(Workgroup)*
- Evaluate project proposals to meet these RM&E needs *(Workgroup)*
- Obtain ISRP review of project proposals *(Workgroup)*

- Complete an inventory of what, where, when, and who, for existing regional RM&E projects and programs to assess current coverage, areas of needed coordination, and cost sharing opportunities across existing federal, state, and tribal agency programs *(PNAMP and CSMEP)*
- Add Fish and Wildlife Program proposed projects to the inventory of RM&E *(Workgroup)*
- Develop a set of project selection criteria *(Workgroup)*
- Use the selection criteria and the regional inventory of existing and proposed RM&E projects to perform a gap and prioritization assessment *(Workgroup)*
- Identify cost sharing opportunities and responsibilities of other regional entities *(Workgroup and Regional Research Partnership)*
- Recommend funding high priority projects and gaps within allocated funding levels
- Develop targeted requests for proposals to fill remaining high priority gaps *(Workgroup)*

In sum, the preceding steps will be used to identify existing projects that are relevant; identify new proposals that are relevant; and, identify any significant gaps. These steps are subject to change as the overall process for project selection is under development.

Current and Proposed Monitoring Components of the Program

This section provides a description of ideas and examples of how this process can move forward. It is essential to maintain and broaden the scope of monitoring to support the Program, for example broadening the use of probabilistic habitat sampling. Two additional areas of importance are the monitoring needs associated with the FCRPS Biological Opinion and recovery plans.

Preliminary staff recommendation: This recommendation is organized by the components of monitoring needed for Program evaluation. These components interrelate in providing information on the overall status of fish and wildlife populations in response to Program measures.

1. Hydrosystem survival: The Council will confirm with NOAA Fisheries, the federal action agencies, and the region's fish and wildlife managers that the design and methods of smolt and adult passage monitoring meets current management needs for guiding river operations annually and evaluating trends in passage survival. The staff has asked Bonneville to review these functions for meeting the requirements of the current Biological Opinion. The Council will determine that the data from passage monitoring is collected and made available consistent with the Program.

2. Habitat: The Council is developing priorities for the collection of data to evaluate changes in watershed conditions relative to the assessments used for the first set of subbasin plans. Because much of that data comes from other funding agencies, the Council will set priorities for collecting such data regionally and to support confirmation

of monitoring protocols for regional consistency. The Council is also prioritizing limited research focused on habitat project effectiveness.

2a. Watershed condition data funded through the Program: Where projects are prioritized to collect data that indicate the condition of habitat for fish and wildlife, the Council recommends that such data be focused first on the priority indicators needed to inform future subbasin planning. For discussion purposes in this memo, those indicators are: water temperature, benthic macro-invertebrate assemblages, passage, flow, large woody debris, sedimentation, dissolved oxygen, nutrients, stream morphology and species functions and redundancy.

The Council intends to prioritize funding away from project tasks focused on collecting data on other attributes, or that serve only to inform evaluation of the individual project, unless there is specific justification. This transition should be accomplished within three years or the next call for project recommendations.

2b. Aquatic Habitat[pjp1] ***project effectiveness:*** The Council in its guidance for the 2007-2009 solicitation stated that monitoring for individual habitat projects should be limited to five percent of the project costs. The staff recommends that the strategy to obtain more information on the effectiveness of habitat restoration on fish survival be to give priority to three "intensively monitored watersheds" experiments. These are being developed in the Wenatchee, John Day and Salmon River subbasins and were initiated during the last Mainstem/Systemwide process. With PNAMP's ongoing coordination, these three projects are linked to similar work on the Pacific Coast funded through other sources. In confirming future funding for these experiments, the Council should consider the strength of these experiments in being able to demonstrate that discrete habit actions result in measurable change in fish survival.

3. Population status and trends: The Program currently funds a wide array of population monitoring which supports both management and ESA delisting analysis. Other work in the basin is funded from other sources such as license fee revenue and other mitigation programs.

For anadromous fish population monitoring proposed for funding in the Program, the Council expects the methods to be consistent with the randomly distributed sampling designs endorsed by the ISRP in its 2005 retrospective report. Prioritized proposals using other sampling designs should provide a transition plan as part of Bonneville contracting.

The appropriate distribution of monitoring sites for abundance, productivity and diversity needs more discussion as part of ESA recovery planning. Distribution may also be determined by the adoption of provincial objectives into the Council Program, currently planned for 2007. Pending those determinations, the Council staff proposes to complete a rough inventory of the distribution of monitoring in the currently funded program. When coverage to support ESA delisting requirements and provincial objectives is determined, the Council will plan a transition to support the prioritized distribution.

Where population monitoring for resident fish is prioritized for funding through the Program, the appropriateness of methods will continued to be reviewed by the ISRP. The staff does not propose a standard protocol at this time.

For wildlife population monitoring, the ISRP has continued to urge the Council to prioritize census monitoring to measure the response of target populations to acquisition and management of habitat. Currently, the Program calls for monitoring habitat value using the Habitat Evaluation Procedure (HEP) methodology. Periodic surveys of the quality of habitat protected by the Program are efficient and will be prioritized in the Mainstem/Systemwide Review. More directly estimating the changes in target wildlife species population and determining the specific influence resulting from habitat acquisitions is likely to be more expensive and will require the development of landscape level population estimates. The staff recommends continuing to use the HEP methodology as an accounting mechanism for tracking Bonneville's obligations for wildlife mitigation but will continue to review alternative procedures for monitoring population respones as proposed by the ISRP.

4. Hatchery monitoring: The Program funds significant activities related to hatchery performance. There are two issues for Council guidance in the 2007-2009 project selection process: linking the Program's supplementation effectiveness monitoring into a more integrated regional experiment, and the level of funding for monitoring of hatchery performance against project objectives and effects on naturally spawning populations. The Council also continues to collaborate on regional hatchery review and reform processes.

4a: Designate the design of an integrated supplementation experiments a priority action: The monitoring designs for each of the Program's supplementation projects have received ISRP review for design and outcomes. The ISRP is reviewing each project's design again this year. However, both the ISRP and ISAB have urged that the monitoring of projects be linked together so that the results from one project might serve the needs of others and diminish the need for each project's design. For example, the control stream used for one project might serve others with similar applications of supplementation techniques. The staff recommends that the Council prioritize development of an integrated regional design for completion and scientific review in 2007.

4b. Hatchery performance monitoring: The staff recommends funding in 2007-2009 monitoring that the ISRP review determines is appropriate, subject to budget capacity. The Council staff and Bonneville should determine that the data from each project's monitoring is being reported to the region consistent with the Program's standards for timeliness and accompanying metadata.

5. Estuary habitat status and trend monitoring: As called for in the Program, the ecological status of the Columbia River estuary and plume has been treated as a planning unit in subbasin planning and project selection. The 2000 and 2004 Biological Opinions also assigned responsibility to the federal action agencies for monitoring of the estuary.

Although there have been several successful estuary research project, the design of a pilot estuary monitoring project has not been successful in independent scientific review. Proposals have been made for 2007-2009 and are being reviewed by the ISRP. Monitoring the conditions of the estuary involves a number of other funding partners so the staff will focus on the appropriate role for Bonneville funding in the 2007-2009 project selection process.

6. Ocean harvest monitoring: Program funding supports monitoring of harvest in the ocean through at least two methods: directly through funding of coded wire tag programs and indirectly through dam counts. The staff recommends addressing the adequacy of information and appropriate share of Bonneville funding in the Mainstem/Systemwide project review.

7. Data management: Collecting the data from each of these monitoring components requires specific commitment for delivery to regionally accessible sources. The Council has a memorandum of agreement with other regional parties to confirm a work plan for a web-accessible data portal. The mainstem/Systemwide project review will prioritize funding for a request for support of the portal with other funding partners. The review will also review the necessary scope and functions of the Streamnet project, which is the primary collector and maintainer of data from Program-funded projects. The staff recommends working with sponsors and Bonneville project managers to determine if proposed ongoing projects deliver their data to regional sources consistent with the Program. The staff recommends that meeting this standard become a condition of future contracting and verified by Bonneville project managers as part of project performance review.

8. Basinwide and province performance evaluation: The Program calls for adopting province-scale objectives which will serve as benchmarks to assess how individual actions in subbasins are adding up at broader scales. The Council plans to open the Program for proposed amendments to adopt provincial objectives this year.

Performance against these objectives will guide future funding allocations and management emphasis. From the data collected from the monitoring components listed above, the staff recommends that monitoring of performance against provincial and ESA objectives use specific “high level indicators” and for discussion in this draft, those indicators are:

- Adult Fish Abundance
- Fish survival or productivity indicators
- Spatial distribution
- Annual population growth rates
- Ocean productivity indices
- Hatchery releases and return rates
- Habitat conditions, summarized from the watershed condition indicators
- Harvest rates
- Adult and juvenile passage survival through the mainstem dams

9. Reporting: The staff recommend making funding for the production of an annual report that summarizes the data from the high level indicators proposed above a priority. The Columbia Basin Fish and Wildlife Authority is funded to produce an initial summary report for 2006. The staff expect the content to evolve as provincial objectives are adopted into the Program and specific indicators are confirmed. In the meantime, the staff recommends that the Council review and approve the content for the initial report funded for 2006. CBFWA is presenting an initial content proposal to the Council's Fish and Wildlife Committee at its March meeting.

The staff also recommends making funding for an on-line peer-reviewed journal for Program-funded research a priority. Specific proposals or an appropriate placeholder for an RFP for such a journal will be reviewed in the Mainstem/Systemwide proposal review.

IV. Program Evaluation Requires Broad Range of Monitoring

The ISRP, in their Retrospective Report (ISRP 2005-14), provided recommendations for monitoring priorities to the Council that will be helpful in the development of a regional approach to monitoring. They pointed out that an extensive long-term status-monitoring program can identify important and unexplained trends and changes. The ISRP suggested that the approach embodied in the four priorities they recommend is the most likely to accomplish successful large-scale, long-term research, monitoring, and evaluation programs. These priorities are reported in the appropriate topic section. This chapter provides explanation of the monitoring activity set forth in Appendix A. (The categories of monitoring within the Regional Framework are explained in Appendix C.)

Monitoring and Action Effectiveness Research

This section identifies priorities for 1) Fish/Wildlife Population and Environmental Status and Trend Monitoring and 2) Action Effectiveness Research. These two components of monitoring are discussed together because monitoring for action effectiveness research projects is often coordinated with regional status and trend monitoring that may be occurring within the study area. PNAMP, the RME Workgroup of the Federal Caucus, NOAA Fisheries, The ESA Technical Recovery Teams, The Oregon Plan and the Washington State Forum have identified priorities for monitoring and action effectiveness evaluations. Subbasin and recovery plans outline these priorities incompletely but are instrumental in matching them up with population limiting factors. Thus, the development of a coordinated regional approach to monitoring will continue to require planning, assessment, and research with other regional entities into the future.

Develop Common Protocols for Fish/Wildlife Population and Environmental Status and Trend Monitoring

Fish or wildlife population and/or environmental conditions monitoring is defined as census or statistically designed monitoring to assess the current status or change (trend) over time and includes ecosystem/landscape level, broad-scale, periodic monitoring (Tier 1 Monitoring) and geographically localized, frequent monitoring (Tier 2 Monitoring). Biological monitoring programs for example, coordinated and standard methods for estimation of spawners/escapement, coordinated and standard methods for monitoring of habitat, etc.

A primary need for monitoring is the development of data collection methods that will result in a common currency for statistically valid analyses. The region needs a coordinated approach to monitoring at different scales to ensure consistency in data collection and to provide a basis for “rolling-up” data to higher scales in order to answer evaluation questions at a programmatic scale. This will require development of common monitoring approaches, including quality control/quality assurance programs; shared evaluation tools; integrated status and trend monitoring efforts; land use, land cover, and riparian vegetation categorization; core data for subset of watersheds in all represented

states. (Although, such stratification cannot be applied universally, it will be applied where appropriate.) The objectives are to develop: standardized protocols; the ability to cross walk between protocols; and, connections between protocols designed for different purposes such as habitat assessment protocols for watershed management and protocols for fish population censusing.

The ISRP recommended developing a sound Tier 1 trend monitoring procedure based on remote sensing, photography, and data layers in a GIS format. They recommended that landscape changes in terrestrial and aquatic habitat and land use should be monitored for the smallest units possible, for example pixels or sites. Future technology may allow low cost remote sensing of important parameters such as water temperature. Accuracy and precision of data layers in the GIS should be evaluated by on-the-ground verification using randomly sites. Large-scale Tier 1 trend monitoring of fish populations might include fish counts and condition in by-pass systems at dams, adult counts at dams, and adult counts at weirs.

Population Status, Trends and Distribution

Fish population status and trend data (abundance, distribution, and productivity of all Columbia basin populations) requires further development. This requires regional cooperation and joint funding of standard monitoring designs and monitoring programs to obtain more expanded, robust, and accessible information on adult escapement and smolt production. Furthermore, monitoring is needed to determine the indirect, delayed, or direct mortality levels associated with harvest. This information needs to be combined with more advanced harvest management assessment techniques.

Therefore a standardized set of metrics and compatible protocols for sampling designs and data collection must be identified and developed and implemented. Methods manuals for training and project level consistency must be developed and deployed. An annual symposium that brings decision-makers, monitoring designers, developers, practitioners, and implementers must continue and possibly be expanded.

Develop Common Site Selection Procedures

The implementation and refinement of subbasin plans provides the opportunity to promote the collection of research and monitoring data with common methods throughout the entire Columbia Basin. The ISRP recommended that entities within the Columbia Basin cooperate in the adoption and application of random site selection procedures for population and habitat status and trend monitoring. Use of probabilistically selected sites should be made as soon as possible to avoid inherent biases in subjectively selected and non- co-located study sites. The measurement of indicator variables should be co-located on the same sites to the extent possible. The Program should cooperate with status and trend monitoring plans being developed by the Action Agencies for implementation of the EPA's Environmental Monitoring and Assessment Program (EMAP) probabilistic selection of aquatic sites in pilot projects in the Wenatchee, John Day, and Salmon Subbasins, (see BPA Draft Report "Research,

Monitoring & Evaluation For the NMFS 2000 FCRPS Biological Opinion." EMAP can provide the basis for sampling, but some individual population needs, higher levels of uncertainty, or lack of data will require a Generalized Random Tessellation Stratified (GRTS) plus design (Stevens and Olsen, 2004).

PNAMP has indicated that using a probabilistic sample design as the basis for status monitoring would support data summaries or "report cards" on the condition of key indicators of riverine/riparian/watershed resources and the tracking of changes and trends over time at broad regional scales. Such a sampling proposal would allow the aggregation of data at multiple landscape levels, while simultaneously meeting the needs of individual entities within the region. Objectives include:

- Coordinate state, federal, and tribal watershed status and trend monitoring efforts into an integrated sampling strategy. This may lead to changes in locations or watersheds selected for sampling for both state, federal, and tribal monitoring program sample sites, but would allow for improved efficiencies for use of data across a variety of scales.

- Develop and recommend a regional aquatic monitoring design covering the states of Washington, Oregon, Idaho, and Northern California, using the EMAP probabilistic GRTS + design developed by the EPA to ensure random, spatially balanced placement of sampling sites (Peck, et al. 2001).

Develop Models for Predicting of Abundance

The ISRP recommended developing of empirical models for predicting the abundance or presence-absence of focal species concurrent with the collection of data on status and trends of wildlife and fish populations and habitat. Potential predictor variables include not only physical habitat variables such as flow, temperature, but also measures of habitat recovery actions that are currently in place or are implemented in the future. The empirical models can be used to evaluate the relative importance of physical factors and habitat improvements and to predict abundance or presence-absence throughout major sections of the basin. (It will be important to adequately cover the geographical breadth and biological depth of the region.) If adequate coverage exists with current study sites, it may be advisable to conduct initial analyses on current data.

Habitat Monitoring

Some restoration projects will generate data that is relevant to regional monitoring objectives at scales beyond the project, for example watershed, subbasin, province, ESU, or basinwide. The data generated by such restoration projects presents an opportunity to help populate a regional database that can be manipulated for analytical purposes, for example the assessment of program elements. One example is the need for collection of data on the high level indicators that the region agrees should provide the basis for evaluation at the basin scale. It will be important to regularly assess the effectiveness of these parameters for programmatic scale evaluation.

More specifically, data relevant to the assessment of progress towards or away from provincial scale objectives provides an example of use for program assessment of data collected at projects. In order to develop data that constitutes a common currency, it is essential that projects generating data for higher scale monitoring purposes utilize data collection protocols endorsed by PNAMP for regional use. Combining or rolling up the results of a subsample of projects that were not representative of the Program's efforts to date would yield an inaccurate inference of the Program's effectiveness at the basin-scale. Therefore, it will be important to continue supporting the Upper Columbia, John Day, and Salmon Pilot Studies as testing areas for comparing protocols and sampling methods.

Action Effectiveness Research

Action Effectiveness Research is defined as research to determine the effects of an action or suite of actions on fish survival, productivity and/or habitat conditions (supported by Tier 3 monitoring). Monitoring for action effectiveness research projects is often coordinated with regional fish/wildlife population and environmental status and trend monitoring that may be occurring within the study area. This is experimental research that statistically assesses the effect of a treatment relative to a reference condition. Action effectiveness research can be performed for a localized project or stream reach level effect or for a watershed level effect (intensively monitored effect). Project level effects are most commonly identifying changes in habitat conditions associated with the action, while fish or biological responses may require a watershed level (intensively monitored approach) to capture a broader area in which a biological response is expressed.

Habitat Project Effectiveness

Monitoring of stream and watershed restoration to ascertain the effectiveness of restoration efforts were recently reported in Roni, 2005, and Crawford, 2005. Yet little remains known about how habitat improvements will affect target populations. Quantifying the results of restoration activities by having research projects that compare the effects of restoration projects to control or reference conditions will be fundamental to success. For many restoration actions, the relative recovery time frames are not well quantified. Thus, it will be important to assess not only the projected benefits of a restorative action, but the length of time needed to achieve those benefits and the rate of habitat improvement over time. Detecting change based on a discrete action, or a suite of actions, will be difficult without proper design and even more challenging to ascribe the effect to the biological constituents.

Research should be conducted to assess how fish production changes as actions are implemented or as habitat changes. Currently, such information is lacking for most habitats, though elaborate systems exist to approximate such information for example, EDT. However, simply monitoring change will not be sufficient, a treatment and control experiment is required. It is important to determine what sort of improvements we would expect in habitat and target populations as a result of specific restoration activities.

In their report, Review of Strategies for Recovering Tributary Habitat (ISAB 2003-2), the ISAB recommended that intensive watershed monitoring at selected locations be included in overall strategies for evaluating habitat improvement projects. Understanding the effect of habitat conditions on salmonid population performance requires carefully designed Before-After-Control-Impact or other designs over several generations at the population scale. Few evaluations of tributary habitat in the Columbia River Basin have successfully implemented this level of intensive monitoring (Marmorek et al. 2004).

The expense and effort needed for research experiments evaluating the response of fish and wildlife to habitat restoration and to adaptively manage programs is considerable. It is likely to require several generations of a population to get statistically supported answers to questions about the effectiveness of habitat restoration. This supports an approach of focusing intensive monitoring efforts on a relatively few locations and to involve multiple parties in a collaboratively conducted and funded research effort (see Washington Salmon Recovery Funding Board. 2003a). This type of research has already begun in the context of the Federal RME pilot studies (Jordan et al. 2003, Hillman et al. 2004; WA SRFBa; and WAIMW 2004). By implementing these evaluations with clear objectives, careful employment of experimental and statistical design, disciplined adherence to the experimental constraints in treatment and reference sites, and patience, results can be obtained that will greatly improve the ability to ensure viable fish and wildlife populations.

Intensively Monitored Watersheds

For the reasons described in the preceding section, Washington State has invested heavily in the Intensively Monitored Watershed approach, which holds promise for qualitatively evaluating effectiveness of restoration and generalized action categories. The Program can help complement this effort by:

- Identifying the need for and funding sources for intensively monitored restoration work in large river systems, which are not currently emphasized by Washington State. The John Day River, for example, might be a good candidate for such a study. However, inferences drawn from these subsamples must be carefully scrutinized for their applicability across a variety of eco-types and unique populations life histories.

- Providing supplemental funding for aspects of the Washington IMW research studies that are receiving inadequate attention and possibly expanding the network of IMW's to cover a broader variety of environmental conditions present in the Northwest.

- Providing a venue for stakeholders to participate in the IMW effort in Oregon and Idaho as well. This means bringing these two States into collaboration with what Washington is doing, and encouraging the tribes, federal agencies, and States, to engaged in or lead the work.

Members of PNAMP and other entities working with support from the Pacific Coastal Salmon Recovery Fund have identified additional watersheds for the intensive monitoring of restoration project results. The PNAMP Effectiveness Monitoring Workgroup has developed a document to help guide this parallel activity, "Establishing a Network of Intensively Monitored Watersheds in the Pacific Northwest." The Fish and Wildlife Program is supporting this work via Project #200301700 "Develop and Implement a Pilot Status and Trend Monitoring Program for Salmonids and their Habitat in the Wenatchee and Grande Ronde River Basins." This project is an example of the current development of Tier 2 statistical monitoring for status and trend of salmonids and aquatic habitat over three large subbasins in the Columbia Basin. Concurrently, the Bonneville Environmental Foundation is also supporting similar work in the Chinook River in the lower Columbia and Kootenai. The Program should concentrate on linking with these current efforts, expanding the scope to other eco-types, and carefully managing and balancing technical investments in other watersheds.

Entities interested in conducting effectiveness evaluations of restoration projects should first carefully review work being done by the Washington Salmon Recovery Funding Board, and the IMWs, to determine what types of categories of restoration actions have not yet been evaluated in their ecoregion at the scales of interest. Secondly, these entities should meet with other groups (within their subbasin and/or within other subbasins in the same ecoregion) to develop integrated proposals that encompass a larger sample of this category of restoration action, as well as appropriate reference reaches or populations. Third, these potential effectiveness projects need to be coordinated and integrated within ongoing habitat projects and future project selection processes to insure adequate treatment effects, control sites and minimized confounding by other non-treatment projects. This can maximize the opportunity for contrasts in actions, required for reliable inferences on action effectiveness.

Estuary

Habitat restoration, research, and monitoring in the lower Columbia River, estuary and ocean are important aspects of the Council's Fish and Wildlife Program. There is a need to continue building a coordinated, integrated "estuary" program among the various funding entities and project sponsors. This initiative is being designed to address the estuary/ocean management questions and associated metrics, evaluation methods, and experimental designs. In summary, the key management questions for the lower river/estuary/ocean are:

- Is there a functioning adaptive management process in place to design, collect, analyze, disseminate, and evaluate data to inform decision-makers?

- What is the ecological importance of the Columbia River estuary and oceanic plume to the viability and recovery of salmonid populations in the Columbia Basin?

- Quantitatively, to what extent are we avoiding further loss to existing shallow water wetland habitat and restoring degraded habitats, in particular for listed salmonids?

- Is the off-site mitigation program of habitat restoration in the Columbia River Estuary improving habitat conditions for listed salmonids?

- What are the status/trends in ecosystem structure and function of the Columbia River Estuary?

- What are the annual ocean conditions and how are they affecting salmon survival?

Artificial Production Effectiveness

Monitoring the effects of artificial production on population health is currently conducted project-by-project, yet constitutes a significant component of the current monitoring budget. Some ongoing artificial production projects have monitoring planning or research elements embedded in them and are coordinating their development with programmatic research, monitoring, and evaluation activities, for example, Northeast Oregon Hatchery, Idaho Supplementation Study, Umatilla, Yakima Fishery Project, and the Nez Perce Tribal Hatchery. In their report "Monitoring and Evaluation of Supplementation Projects," the ISAB and ISRP concluded that monitoring and evaluation of supplementation projects is critically important, and that:

- For the monitoring to be effective, a very rigorous design is needed, and the scale and logistics of implementation will carry costs that are significant. The scientific issues underlying the definitions of performance metrics and the necessary controls in the design are genuinely complicated. Some of the scientific tools for measuring performance are new, and involve a level of knowledge of population and molecular genetics which until recently has not been part of the standard fisheries curriculum

- The consequences of not conducting these studies and continuing to assume no deleterious impacts from supplementation, and being wrong, are much greater than short-term changes in salmon abundance. The natural populations that may be lost if supplementation actually decreases their fitness are irreplaceable. On the other hand, if supplementation proves an aid to natural population during distress, further application may be warranted. Both outcomes remain uncertain without adequate monitoring and evaluation, which will likewise guide best management practice and cost effectiveness

Hydro Related Research, Monitoring and Evaluation

Hydro related research, monitoring and evaluation in the Snake-Columbia River System, are important elements contained in the Program. There is a need to coordinate these Program activities with those funded under the USACE Andromous Fish Evaluation

Prorgam (AFEP). In combination these two programs direct and fund Hydro-related RME activities many of which are described in this portion of the program. These RME activities are designed to address the Hydro-related management questions and associated metrics, evaluation methods, experimental designs, etc. as described and summarized in the accompanying Appendix A.

Uncertainties Research

Uncertainties Research is empirical research, for example experimental research that requires hypothesis testing using statistical designs for before and after conditions or parallel treatment and controls or reference conditions. Uncertainties Research is a long-term strategy, intended to resolve scientific uncertainties regarding the relationships between: fish or wildlife health, population performance (abundance, survival, productivity, distribution, diversity); habitat conditions; life history and/or genetic conditions (existence and causes of delayed mortality); and, hatchery spawner reproductive success relative to wild populations.

Project Implementation/Compliance Monitoring

These types of monitoring address the execution and outcomes of projects. Project implementation monitoring determines whether projects were carried out as planned and constitutes a lesser level of effort and resource allocation. This is generally carried out as an administrative review and does not require any parameter measurements beyond those specified by the project design requirements. Project implementation monitoring documents the type of management action, the location, and whether the action was implemented properly or complies with established standards. This type of monitoring does not directly link restoration actions to physical, chemical, or biological responses, as none of these response parameters are measured. It does not require environmental response data and is usually a low-cost monitoring activity that should be included for all mitigation or restoration projects. This category can be used to track compliance with existing regulatory mechanisms and laws however such as state Growth Management, Critical Areas Ordinances, permitting processes and variance-granting procedures by local governments. This is key to ensure that “threats” to future viability are being addressed in land use and development processes as they represent significant impediments to mitigation, conservation and recovery of basin fish and wildlife species and populations.

Project compliance monitoring determines whether specified project criteria are being met. Project compliance monitoring of restoration projects will be used to assess the status of contract compliance and to provide a form of post project auditing of project performance. Only a percentage of program projects will have annual or periodic compliance monitoring after a project is completed.

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VI. Appendices

Appendix A. Regional Monitoring Framework

RM&E Framework Component	Management Questions	Subordinate Questions	Regional Information Needs					
			Metrics	**Data Required**	**Survey or Experimental Design**	**Spatial Scale**	**Temporal Scale**	**Agencies[1] with Cost Sharing Responsibilities**
Tributary Habitat Status and Trend Monitoring	Are Columbia Basin fish populations meeting population level objectives (abundance, productivity, and diversity)?							
		What is size of adult salmonid and resident fish populations?	Numbers of adult fish	Numbers of adults, spawners, or redds	Census or spatially balanced survey[2]	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
		What is the distribution of salmonid and resident fish populations??	Presence/absence of adult fishes	Presence of adults, spawners, or redds	Census	Columbia Basin, ESU, Population, Core Area, or Sub-population	Sampling every 3 to 5 years	1st: FR, S, T 2nd: AA, LU
		What is the growth rate of adult salmonid and resident fish populations??	Returns/Spawner, Lambda, Temporal Trends	Numbers of adults, spawners, or redds	Census or spatially balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual for at least 3 generations	1st: FR, S, T 2nd: AA, LU
		What is the freshwater	Smolts, fry or parr	Number of	Census or spatially	Columbia Basin,	Annual	1st: FR, S, T

[1] FR= Fish Regulatory Agencies (NOAA and/or USFWS); AA= FCRPS Action Agencies (BPA, COE, BOR); LU= Land Management Agencies (USFS, BLM); EPA= Environmental Protection Agency; S = State Agency; T= Tribe

[2] Spatially-Balanced Survey Design (e.g., EMAP-GRTS design; see Stevens and Olsen 2004)

		productivity of these populations?	produced per adult, spawner, or redd	smolts, fry or parr	balanced survey	ESU, Population, Core Area, or Sub-population	sampling	2nd: AA, LU
		What is the age structure of these populations?	Age of returning adults or spawners	Otolith, scale, or length of adults or spawners	Census or spatially balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
		What fraction of the spawners of these populations is of hatchery origin?	Ratio of hatchery to total fish abundances	Number of hatchery produced adults or spawners	Census or spatially-balanced survey	Columbia Basin, ESU, Population, Core Area, or Sub-population	Annual sampling	1st: FR, S, T 2nd: AA, LU
	Are aquatic, riparian, and upland ecosystems of the Columbia Basin being degraded, restored or maintained relative to desired conditions or objectives?							
		What is the biological condition of spawning and rearing habitat for Columbia Basin fish populations?	Macro-invertebrate and fish assemblages		Spatially-Balanced survey	Stream, watershed, subbasin	Annual sampling	1st: FR, EPA, S, T 2nd: AA, LU
		What is the physical condition of spawning and rearing habitat for Columbia Basin fish populations?	Valley characteristics (valley bottom types, valley widths and gradients, valley containment, road density, land ownership, land use); Channel characteristics (bed-form types, channel types, gradient, width/depth ratio,		Spatially-balanced survey [1]	Stream, watershed, subbasin	Annual sampling	1st: LU, S, T 2nd: AA, FR

			stability); Riparian vegetation (structure, disturbance, canopy cover); Habitat access (dams and diversions); Stream flows; Habitat quality (substrate, embeddedness, large woody debris, pools, off-channel habitat, fish cover)					
		What is the water quality in spawning and rearing habitats for Columbia Basin fish populations?	Temperature, Turbidity, Conductivity, pH, Dissolved Oxygen, Nutrients, Toxic Pollutants and Heavy Metals		Spatially-balanced survey	Stream, watershed, subbasin	Annual sampling	1st: EPA, S, T, LU 2nd: FR, AA
Tributary Habitat Action Effectiveness Research	What actions are most effective at addressing the limiting factors preventing achievement of habitat, fish or wildlife performance objectives?							
		Did all tributary habitat actions in aggregate for a sub-population increase juvenile survival or adult abundance, compared to a similar sub-population with few or no habitat actions?	Type, location, timing and intensity of habitat actions, and juvenile survival or adult abundances	Depends on management actions	Large-scale Before-After (BA) Studies[3]	Watershed, Subbasin	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU
		What contribution did all tributary habitat actions for an ESU	Type, location, timing and intensity of habitat actions, and ESU	Depends on management actions	Large-scale Before-After (BA) Studies	ESU scale	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU

[3] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005

		make toward increasing the ESU-level population growth rate?	population growth rates					
		Did a single tributary habitat action increase local fish abundance or distribution, or improve local environmental conditions, compared to a similar control or reference site?	Type, location, timing and intensity of habitat action, local fish abundance or distribution, and/or habitat conditions	Depends on management actions	Project-scale Before-After Studies[4]	Stream, Watershed	Depends on management action(s)	1st: AA, LU, S, T 2nd: FR
		Did some classes of actions (e.g., riparian restoration actions) perform better than other classes (e.g., passage improvement actions) in improving localized conditions or sub-population juvenile survival rates?	Type, location, timing and intensity of habitat actions, and local habitat conditions and/or juvenile fish survivals	Depends on management actions	Project-scale Before-After Studies	Stream, Watershed	Depends on management action(s)	1st: AA, S, T 2nd: FR, LU
Tributary Habitat Uncertainty Research	What are the limiting factors or threats preventing the achievement of desired habitat, fish or wildlife performance objectives?							
		What is the relationship of habitat processes and functions of upslope, riparian, and aquatic systems to biological	Watershed condition metrics identified above.	Watershed condition data identified above.	Depends on correlation or experimental approach	Stream, watershed, subbasin	Depends on correlation or experimental approach	1st: LU, S, T, EPA 2nd: FR, AA

[4] Intensive BA, Extensive BA, or replicated BACI; see Roni et al. 2005

		and environmental habitat attributes?						
		What is the relationship of habitat attributes, processes, and/or functions to fish and wildlife abundance, productivity, and diversity?	Watershed condition and fish population metrics identified above.	Watershed condition and fish population data identified above.	Depends on correlation or experimental approach	Stream, watershed, subbasin	Depends on correlation or experimental approach	1st: FR, S, T 2nd: AA, LU, EPA
Hydro Status and Trend Monitoring	Are salmon and steelhead meeting juvenile and adult hydro passage objectives?	Are smolts achieving survival standards prescribed in the NOAA BOs?	Smolt survival estimates through impounded reaches of the Snake and lower Columbia System survival estimates reflecting delayed effects of transported smolts	PIT tag detection histories through the FCRPS Tagging ample # of fish at hatcheries as surrogates for wild ones. Annual estimates of D	Cormack-Jolly-Seber single release model	LGR to BON tailrace, when possible	Annual	1st: AA 2nd: FR
		Are adults achieving survival standards prescribed in the NOAA BOs?	Survival indices of adult salmon and steelhead through the FCRPS. *NOTE- AFEP funds some, but not all, data elements required under this objective. Close coordination with AFEP required*	PIT detection histories at ladder-based detectors, for known source fish. Estimates of stray rates Estimates of harvest removals of PIT tagged fish in the Mainstem. Estimates of incidental harvest mortality, e.g.,	Accounting of fates for returning PIT tagged fish.	BON to uppermost dam as applicable to an ESU	Annual	1st: AA 2nd: FR

				net drop out rates, catch and release related mortality, etc.				
Hydro Action Effectiveness Research	*NOTE- AFEP funds elements required under this objective. Close coordination with AFEP is required.*							
Hydro Uncertainty Research	What is the magnitude of delayed effects associated with transporting smolts?	Under what conditions does inriver passage yield higher SARs than transport?	Estimates of D for wild and hatchery fish	PIT tag detections juveniles and returning adults SAR for transport and inriver groups, i.e. TIR estimates Inriver survival estimates Direct transport survival estimates	Empirical estimates & model derived estimates for populations of some inriver migrants	Individual transport sites to designated return site.	Annual	1st: AA 2nd: FR
		Is transport appropriate for some locations and not others?	TIR estimates for wild and hatchery fish					1st: AA 2nd: FR
	Do smolts migrating through the FCRPS incur delayed effects?	What is the magnitude of such effects?	SARs linked to different smolt passage fates or experiences	PIT tag detections as juveniles to describe migratory experience PIT detections of returning adults	Compare SAR among treatment groups	Variable	One to several years	1st: AA 2nd: FR
		What are the causes and can they be rectified?	Localized smolt survival rates (Identify zones of particularly intense mortality that could depress SAR)	Variety, e.g. PIT, acoustic tag or radio telemetry data from smolts.	Compare survival with reference areas.	Geographically localized, e.g. bird predation centered at islands	One to several years	1st: AA 2nd: FR

Estuary Habitat Environmental Status and Trend Monitoring	Are aquatic, riparian, and upland ecosystems of the estuary (from Bonneville Dam to the mouth of the Col. R.) being degraded, restored or maintained relative to desired conditions or objectives?	Using a hierarchical habitat classification system based on existing hydro-geomorphology, to what quantitative extent are we avoiding further loss to existing shallow water wetland habitat and restoring degraded habitats, in particular for listed salmonids?	Characterization of Vegetation cover, Geology/ soils, Floodplain topography, Bathymetry	Habitat classification	Census (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What is the amount of habitat in absolute acreage, by habitat type, that was restored annually and by proportion of the total lost historically for each habitat type for each reach of the CRE?	Measurements of Area affected	Habitat classification Habitat condition	Census (mensurative) or spatially balanced survey	BON to mouth	Annually	1st: FR 2nd: AA, S
		What is the index of habitat connectivity by reach and its status/trend?	Connectivity -- Inventory of Passage barriers and Total edge, density and sinuosity of floodplain and tidal channels.	Habitat connectivity	Census (mensurative) or spatially balanced survey	BON to mouth	Annually	1st: FR 2nd: AA, S
	What are the status/trends in attributes of the CRE, plume, and ocean ecosystems?	What are estuary habitat physical properties?	Habitat -- Characterization of Vegetation cover, Geology/ soils, Floodplain topography, Measurements of Bathymetry	Habitat condition and classification	Statistical (mensurative) or Spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are estuary fish population properties, especially with respect-listed	Fish – Estimates of Species composition, Age/size-structure, Stock identity, Temporal distribution,	Life history diversity, spatial distribution, growth, survival	Statistical (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S

		salmonids?	Spatial distribution, Migration pathways, Growth rate, Residence time, Prey availability, Foraging success, Survival rate, Predation index					
		What are estuary hydrograph and water quality properties?	Water -- Measurements of Hydrograph, Temperature, Salinity, Dissolved oxygen, pH, Turbidity, Nutrients, Toxics	River discharge, water quality	Statistical (mensurative) or spatially balanced survey	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are invasive species properties?	Invasives -- Invasive species list, Invasive spatial distribution, Invasive abundance	Invasive species assessment	Statistical (mensurative) or spatially balanced survey	BON to mouth	3 yrs	1st: FR 2nd: AA, S
		What are the environmental conditions and salmon ecology in the Col. R. plume and ocean relative to salmon production and survival?	Plume and Ocean -- Estimates of Juvenile salmon usage, Growth, Survival, Zooplankton prey base, and Anchovy/ herring index in the plume and Measurements of Sea surface temperature, Northern oscillation index, Upwelling index, chlorophyll	Ocean and plume conditions, Growth, residence time, survival,	Statistical (mensurative) or spatially balanced survey	Plume and N. Pacific Ocean	Depends on metric	1st: FR 2nd: AA, S
Estuary Action Effectiveness Research	What actions are most effective at addressing the limiting factors preventing achievement of habitat, fish or wildlife performance objectives?	What is the cumulative effect of multiple habitat restoration projects on the CRE ecosystem?	See "Connectivity", "Habitat" and "Fish" above	Habitat cond's, habitat connectivity, fauna, life history diversity, spatial dist., growth, survival, predation, water quality physical cond.,	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are the effects of	See "Connectivity",	Habitat	Effectiveness	BON to mouth	Annually	1st: FR, AA

		hydrologic reconnection projects (e.g., dike breaches, new tide gates and culverts) and revegetation projects?	"Habitat", "Fish" and "Invasives" above	connectivity, life history diversity, spatial dist., growth, survival, invasive species	(mensurative) or Project-scale Before-After Studies			2nd: S
		What possible changes to FCRPS operations might improve habitat conditions in the CRE for Columbia basin salmonids?	Ibid.	Ibid.	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to plume	Depends on metric	1st: FR, AA 2nd: S
Estuary Uncertainties Research	What are the limiting factors or threats in the estuary preventing the achievement of desired habitat, fish or wildlife performance objectives in the Col. Basin?	What is the ecological importance of the Columbia River estuary and oceanic plume to the viability and recovery of salmonid populations in the Columbia Basin?	See "Connectivity", "Habitat", "Fish", "Invasives" and "Plume and Ocean" above	Habitat cond's, habitat connectivity, fauna, life history diversity, spatial dist., growth, survival, predation, water quality physical cond., river discharge, plume conditions	Effectiveness (mensurative) or Large-scale Before-After (BA) Studies	BON to plume	Depends on the metric	1st: AA 2nd: FR, S
		What are the effects of toxics on salmonids?	See "Fish" above, plus estimates of concentrations and distributions of Toxics	Water quality, life history diversity, spatial distribution, growth	Depends on correlation or experimental approach	BON to mouth	Depends on metric	1st: FR 2nd: AA, S
		What are the causal mechanisms affecting survival of juvenile salmon during their first months in the ocean?	See "Fish" and "Plume and Ocean" above	life history diversity, spatial dist., growth, survival, predation plume conditions	Depends on correlation or experimental approach	BON to plume	Depends on metric	1st: FR 2nd: AA, S
		What is the survival rate by species of juvenile salmonids migrating downstream	Estimates of smolt survival rates, predation indices	Survival	Cormack-Jolly-Seber single release model	BON to mouth	Seasonally	1st: FR 2nd: AA, S

		from Bonneville Dam to the mouth of the Columbia River?						
Hatchery Status and Trend Monitoring	What is the relative proportion of hatchery spawning salmon and steelhead compared to wild fish populations?		Ratio of hatchery fish to total fish abundance	Numbers of hatchery-origin and natural-origin fish on spawning grounds	Develop requisite marking guidelines and proceed with the marking of remaining groups of unmarked fish released from hatcheries to facilitate monitoring of hatchery-origin fish in natural spawning areas	Census or spatially balanced survey	Annual sampling	1st: AA 2nd: FR
Hatchery Action Effectiveness Research	Can hatchery reforms reduce the deleterious effects of artificial production on listed populations, thereby contributing to a reduction in extinction risk for affected natural populations?		Returns/spawner, lambda, temporal trends, or other metrics as determined by experimental design	Numbers of adults, spawners, or redds, or other data as determined by experimental design	Studies of modified hatchery practices ("reforms") that involve controlled experiments designed and replicated sufficiently to provide statistically and biologically meaningful results pertinent to multiple programs.	As required by experimental design	As required by experimental design	1st: AA 2nd: FR
	Can properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations?		Returns/spawner, lambda, temporal trends	Numbers of adults, spawners, or redds	Treatment and control studies using existing safety-net programs intended to reduce extinction risk of targeted populations.	Selected populations	Annual	1st: AA 2nd: FR
Hatchery Uncertainties	What is the reproductive success of		Number of offspring produced by hatchery x	DNA pedigree analysis	Hatchery/wild	Selected populations	Annual for 2 or 3	1st: AA 2nd: FR

Research	hatchery fish spawning in the wild relative to the reproductive success of wild fish?		hatchery, hatchery x wild, and wild x wild matings in natural spawning areas and subsequent adult returns from each type of cross		reproductive success studies		generations	
Harvest Status and Trend Monitoring	What are the boundaries of uncertainty around harvest point estimates?	What are the harvest rates on listed wild fish?	Numbers of adult fish harvested and numbers of adult fish escaping	Dam Counts; harvest estimates; PIT tag detections at dams	Census at Dams; sub-sample in fisheries	Columbia Basin; ESU	Continual during fishery	1st: FR 2nd: AA
Harvest Action Effectiveness Research	Are new selective gear types effective at harvesting?		Catch Per Unit of Effort; Catch related to capital and operating expense	Standardized measures of catch and effort		Columbia Basin, ESU	Continual during fishery	1st: FR 2nd: AA
Harvest Action Effectiveness Research	What is the post-release survival of salmon caught in a mark-selective fishery compared to fish that were not harvested?		Survival rates	Tagging for fish that are caught compared to those not caught	Treatment/control	Columbia Basin, ESU	Continual during fishery	1st: FR 2nd: AA
Predator Status and Trend Monitoring	What is the impact of predators on juvenile salmonids within the Columbia River Basin?							
		What are the nesting distribution, colony size, and colony productivity for the major avian predators within the Columbia River Basin?	Presence/absence of avian predator colonies, colony size, number of nesting pairs, reproductive chronology, reproductive success rates	Colony location, colony size, number of nesting pairs, timing of reproductive events, reproductive success	Census; statistical sample	Columbia Basin or colony	Annual sampling	1st: AA 2nd: FR
		What are the juvenile salmonid consumption rates of major avian predators within the	Diet composition, consumption rates	On-colony PIT tag deposition rates and detection	Statistical sampling of targeted populations	Columbia Basin or colony	Annual sampling	1st: AA 2nd: FR

		Columbia River Basin?		efficiency, diet samples, bill load observation				
		What are the consumption rates of major pisciverous predators in the Columbia River Basin?	Abundance, distribution, diet composition, fecundity consumption rates	Abundance, distribution, diet composition, consumption rates	Statistical sampling of targeted populations	Columbia Basin	Annual sampling	1st: AA 2nd: S
	What is the impact of predators on adult salmonids within the Columbia River Basin?							
		What are the consumption rates of mammalian predators (marine) in the Columbia River Basin?	Abundance, distribution, consumption rates, diet composition	Abundance, distribution, consumption rates, diet composition	Census or statistical sampling	Columbia Basin (BON to estuary)	Annual	1st: FR 2nd: AA, S
Predator Action Effectiveness Research	What are the most effective management alternatives/actions that could be used to reduce the impact of predators?							
		What is the effect of alternative management alternatives/actions used to reduce the impact of avian predators?	% Change in Juvenile Salmonid Survival, % Change in Avian Predation Rate	Colony location, colony size, number of nesting pairs, timing of reproductive events, reproductive success, On-colony PIT tag deposition rates and detection efficiency, diet samples, bill load observation	Large-scale Before-After (BA) Studies[5]	Columbia River, alternate habitat location, or colony	Depends on management action(s)	1st: AA 2nd: FR

[5] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005

		What is the effect of management alternatives/actions used to reduce the impact of pisciverous predators?	% Change in Juvenile Salmonid Survival, % Change in pisciverous Predation Rate	Abundance, distribution, diet composition, fecundity consumption rates	Large-scale Before-After (BA) Studies	Systemwide Columbia Basin	Depends on management action(s)	1st: AA 2nd: S
Predator Uncertainty Research								
Wildlife Status and Trend Monitoring								
Wildlife Action Effectiveness Research	What are the species response to the various protection/restoration efforts?	How has the mitigation target species responded to fee title versus conservation easements?	Target species abundance for pre/post protection measure	Numbers of adults by target species	Large-scale Before-After (BA) Studies[6] or Project-scale Before-After Studies[7]	Columbia basin	Depends on management action(s)	1st : S,T 2nd : LU
		How has the mitigation target species responded to various habitat enhancement efforts?	Target species abundance for pre/post enhancement measure	Numbers of adults by target species	Large-scale Before-After (BA) Studies or Project-scale Before-After Studies	Columbia basin	Depends on management action(s)	1st : S,T 2nd : LU
Wildlife Action Effectiveness Research								

[1] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005
[1] Intensive BA, Extensive BA, or replicated BACI; see Roni et al. 2005

[6] Intensive BA, BACI, or Staircase designs; see Roni et al. 2005
[7] Intensive BA, Extensive BA, or replicated BACI; see Roni et al. 2005

Appendix B. Definitions of Monitoring Terms

In the Columbia River Basin several large-scale planning documents have categorized three types of monitoring in a hierarchical sequence for example, the All-H Paper, the 2000 FCRPS Biological Opinion, and the Retrospective Report of the Independent Scientific Review Panel (ISRP). The three types of monitoring differ in terms of their application, and along spatial and temporal scales. In their retrospective Report 1997-2005, the ISRP and ISAB recognized the "inconsistent terminology concerning research, monitoring, and evaluation among the various fields of science for example, fisheries, hydrology, wildlife, genetics" and in particular with the scientific basis for "effectiveness monitoring" of management actions (ISRP 2005-14). The ISRP and ISAB have used the words "Tier 1, Tier 2, and Tier 3" in a slightly different manner in past reports referring more to the way data are collected, for example census versus sample, than to the scale of the study. To eliminate potential confusion in the future, they have dropped the use of the word "Tier" when referring to the way data are collected. The relationship of the ISRP's definitions of census and statistical monitoring to Action Agency (2002) Tier 1, 2 and 3 monitoring is shown below (*see* ISRP's Retrospective Report 1997-2005). In addition to monitoring for biological, environmental and physical data, there is compliance and implementation monitoring associated with monitoring of restoration projects.

	Census Monitoring	Statistical Monitoring
Large Scale Tier 1 Monitoring	Usually census monitoring is most appropriate (for example, remote sensing to create GIS data layers).	Statistical monitoring could be useful in special cases (for example, in monitoring range condition on BLM land in Oregon)
Small Scale Tier 2 Monitoring	Usually census monitoring is not appropriate because of high costs of large number of experimental units and/or on-the-ground labor intensive methods.	Statistical monitoring with known precision and confidence based on a sample of units is usually most appropriate (for example, juvenile Chinook salmon abundance in a sample of reaches of the John Day River).
Effectiveness Tier 3 Monitoring	Usually census monitoring is not appropriate because of high costs of large number of experimental units and/or on-the-ground labor intensive methods. **Note:** Not always true. For example, spawning ground / redd surveys where all spawning area in a watershed	Statistical monitoring with known precision and confidence based on a sample of units is usually most appropriate. Rigorous experimental design is required (for example, evaluation of survival of juvenile salmonids past John Day Dam with different levels

	is surveyed = census, not survey. Call Pete Hahn, WDFW, for examples	of spill).

Appendix C. Categories of Monitoring Within the Regional Framework

A regional monitoring framework needs common terminologies for the different categories of monitoring to clarify the discussion of coordination efforts and the identification of current or needed monitoring projects. The following definitions of key categories of research, monitoring and evaluation are consistent with coordination activities between regional federal, state and tribal agencies under PNAMP, the Federal BiOps/Recovery Planning efforts, and the Fish and Wildlife Program:

1. Fish/Wildlife Population and Environmental Status and Trend Monitoring - census or statistically designed monitoring of fish or wildlife population and/or environmental conditions, for example watershed conditions, to assess the current status or change (trend) over time. This monitoring data may also be used to correlate fish performance with environmental conditions.

    - Ecosystem/Landscape level, broad-scale, periodic monitoring (referred to as Tier 1 Monitoring)

    - Geographically localized, frequent monitoring (referred to as Tier 2 Monitoring)

2. Action Effectiveness Research – research to determine the effects of an action or suite of actions on fish survival, productivity and/or habitat conditions (referred to as Tier 3 monitoring). This is experimental research that statistically assesses the effect of a treatment (action) condition relative to a control or reference condition. Action effectiveness research can be performed for a localized effect (project or stream reach level effect) or for a watershed level effect (intensively monitored effect). Localized (project level) effects most commonly identify changes in habitat conditions associated with the action, while fish or biological responses may require a watershed level (intensively monitored approach) to capture a broader area in which a biological response is expressed.

3. Uncertainties Research – research to resolve scientific uncertainties regarding the relationships between fish or wildlife health, population performance (abundance, survival, productivity, distribution, diversity), habitat conditions, life history and/or genetic conditions (for example, the existence and causes of delayed mortality, hatchery spawner reproductive success relative to wild populations, etc.). This is experimental research that involves the manipulation of variables to demonstrate cause and effect relationships using statistical designed hypothesis testing. Uncertainties research does not include experimental research and monitoring specifically targeting the effect of a mitigation or restoration action (this is Action Effectiveness Research). It also does not include monitoring of fish or habitat conditions with statistical correlation assessments (this is Status and Trend Monitoring).

4. Project Implementation/Compliance Monitoring – monitoring the execution and outcomes of projects. Project implementation monitoring determines whether

projects were carried out as planned. This is generally carried out as an administrative review and does not require any parameter measurements beyond those specified by the project design requirements. Project implementation monitoring documents the type of management action, the location, and whether the action was implemented properly or complies with established standards. This type of monitoring does not require environmental response data directly linking restoration actions to physical, chemical, or biological responses. It is usually a low-cost monitoring activity that should be included for all mitigation or restoration projects. Project compliance monitoring determines whether specified project criteria are being met. Project compliance monitoring of restoration projects will be used to provide a form of post project auditing of project performance. This type of monitoring would typically not be carried out by the project sponsor and may require the development of independent, compliance-monitoring projects with one contractor tasked to monitor and assess multiple completed projects. A limited, statistical sample of projects would be monitored annually for compliance.

5. Data Management – support system(s) for data sharing and analysis.

6. Regional Coordination – coordinating processes and agreements across the various Federal, State and Tribal agencies and regional monitoring programs. These processes, agreements and the projects that support them are the glue that connects the network of monitoring efforts that together make up a regional comprehensive monitoring framework.